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Optimized projections and dose slices for the volumetric additive manufacturing of three dimensional objects

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ABSTRACT

Additive manufacturing is one of the most trending technologies in the recent times and the developments have been enormous since the beginning. The capability to produce customized complex geometries helps in the growth of this technology in the areas of aerospace, medical, domestic and industrial applications. The major limitations of all existing processes include high time consumption and surface property issues. Volumetric additive manufacturing is the recent advancement providing solutions for existing polymer based methods. In this method, concurrent printing of all points within an object is done using digital light projection system with effective light patterns generated. In this paper, the projections for complex three dimensional Eiffel tower were calculated based on filtered back projection, soft thresholding and iterative optimization. This is used as the input of a digital light projection system to manufacture the required shape. The number of iterations required for convergence reduced with decrease in angular sampling period.
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1. Introduction

Additive manufacturing processes can be classified based on the dimensionality of the printing process. Almost all commercially available 3D printing technologies use serial unit processes. It can be classified as 0D, 1D, 2D and 3D. Point at once or 0D printing includes processes like fused deposition modelling (FDM), stereolithography (SLA), selective laser sintering (SLS) etc. It prints one point at a time and repeats the operation to get the required target geometry. Line at once or 1D printing comprise material or binder jetting process where an array of nozzles is used to print the entire line at once. Layer at once or 2D printing includes digital light processing (DLP) and continuous liquid interface production (CLIP). These technologies print the entire cross-section of each slice at one time. Continuous liquid interface production is the fastest among these which was developed by Carbon3D. It uses an oxygen permeable membrane to maintain liquid interface between the window and photopolymerizing part [1]. The liquid interface helps in continuous lifting of the required cross-section from a pool of resin unlike digital light processing where higher separation forces are required to separate cured layer from base.

The geometrical capability of the additive manufacturing to create complex shapes has widened the range of applications to meet end use customer products. Advancements in the applications of this technology include high strength to weight components in aerospace, optics, development of tissues and organs, medical devices for human

needs, tools, microarchitecture parts etc. [2,3] Conventional serial processes lack throughput for meeting the consumer demand. Build failures are also high in layer by layer manufacturing pattern. Existing processes from point at once to layer at once methods fail to give dimensional stability to the overhanging structures and support generation is difficult in many geometries. Low surface properties is another limitation. Immense post processing requirements and anisotropy of layer by layer making is another concerns. A new method of 3D printing which could produce all points in the object all at once to solve the above issues were demonstrated by Brett E Kelly et al. from University of California, Berkeley and Lawrence Livermore National Laboratory, Livermore [4]. Simultaneous polymerization of each point in the target geom-

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